

REMARKS

1. Amendments to Claim 1, 2, 13-15 28 and 29

Independent Claim 1 is amended by incorporating the technical characteristics of Claims 10 and 4, which are now cancelled. Claim 1 now claims a regenerative photoelectrochemical cell comprising a photoanode, said photoanode comprising at least one semi-conductive metal oxide layer on a conductive substrate, sensitized by a photosensitizing dye, a counter electrode, an electrolyte arranged between said semi-conductive metal oxide layer and said counter electrode, and an amphiphilic compacting compound whose molecular structure comprises at least one anchoring group, a hydrophobic portion and a terminal group, said compacting compound being co-adsorbed with said photosensitizing dye on said semi-conductive metal oxide layer in a mixed monolayer, and being selected from the group of compounds having one of formulae (1) to (2). The “compacting compound” is now defined in Claim 1.

Claim 2 was objected to as being indefinite because the Examiner believed it did not point out and distinctly claim the subject matter that the Applicant regards as their invention. Claim 2 is amended to recite that the molar ration of said photosensitizing dye to said co-adsorbed compacting compound is of “between 10 and $\frac{1}{2}$ ”; the narrower range/limitation “in particular of between 5 and 1” is deleted.

Claims 13, 14 and 15 depend from Claim 1 and are amended to claim different technical characteristics of the “photosensitizing dye,” for which there is now an antecedent basis in Claim 1.

Claim 28 depends from Claim 27 and is amended to recite that said gelifying compound is a matrix forming polymer, said polymer being selected from the group consisting of polyvinylidene fluoride (PVDF), polyvinylidene-hexafluoropropylene (PVD-HFP),

polyvinylidene-hexafluoropropylene-chlorotrifluoroethylene (PVD+HFP+CTFE) copolymers, polyethylene oxide, polymethylmethacrylate, polyacrylonitrile, polypropylene, polystyrene, polybutadiene, polyethyleneglycol, polyvinylpyrrolidone, polyaniline, polypyrrole, polypyrrole, polythiophene and derivatives thereof. The antecedent basis for the expression “gelifying compound” is found in Claim 27. This amendment is supported by paragraph [0039], lines 1-4 of the published specification.

Claim 29 is amended and now depends from Claim 27. The antecedent basis for the term electrolyte is found in Claim 27.

Claims 4 and 10 have been cancelled.

Applicants submit that no new matter has been introduced by the Claim amendments, and accordingly, Applicants request reconsideration and withdrawal of all the Claim rejections imposed under 35 USC §112.

2. Novelty

2.1. Claims 1-4, 6, 11 and 21-27

Claims 1-4, 6, 11 and 21-27 were rejected under 35 USC 102(a) and 102(e) as being anticipated by Chittibabu et al.

Applicants respectfully request reconsideration and withdrawal of this rejection in the light of the arguments below.

Compounds described by Chittibabu et al. as being a co-sensitizer or sensitizing dye, such as compound 1330, are not encompassed by the compacting compound of formulas (1) or (2) of the photoelectrochemical cell of the present invention. Since independent Claim 1 of the present invention has been amended to recite the specific technical characteristics of the compacting compound, Chittibabu et al. cannot now anticipate the photoelectrochemical cell of

the present invention.

Claims 2, 3, 6, 11 and 21-27 are dependent from Claim 1, which is considered to be novel over Chittibabu et al., and these dependent Claims are believed to be ipso facto not anticipated either by Chittibabu et al.

2.2. Claims 1 and 9

Claims 1 and 9 were rejected under 35 USC 102(b) as being anticipated by Hiroo et al.

Applicants respectfully request the Examiner to reconsider and withdraw this rejection in the light of the arguments below.

Hiroo et al. disclose metal complex dyes having high absorbability of visible and infrared light.

Amended Claim 1 concerns a photoelectrochemical cell comprising a specific compacting compound with a specifically defined anchoring group, hydrophobic portion and terminal group, which is co-adsorbed with the dye (see paragraph [0013] of the published specification). No compacting compound as claimed in amended Claim 1 is taught by Hiroo et al. Therefore, amended Claim 1 is not now anticipated by Hiroo et al.

Claim 9, which depends from Claim 1, is also considered to be not anticipated by Hiroo et al.

3. Obviousness

3.1. Claims 3, 12, 23 and 24

Claims 3, 12, 23 and 24 were rejected under 35 USC 103(a) as being unpatentably obvious over Chittibabu et al.

Applicants respectfully request reconsideration and withdrawal of this rejection in the light of the arguments below.

Claims 3, 12, 23 and 24 are dependent from amended Claim 1, which as amended claims a photoelectrochemical cell comprising specific compacting compounds. Amended Claim 1 is now believed not to be anticipated by or obvious over Chittibabu et al.

Chittibabu et al. discloses a polymeric linking agent for enabling the fabrication of thin film solar cells at relatively low temperatures by interconnecting metal oxide nanoparticles (see Chittibabu et al., page 1, paragraph [0005]). The co-sensitizer of Chittibabu et al. has general structures, namely, anchoring and terminal groups and hydrophobic portions, similar to the structures of compacting compounds of the present invention as presently claimed (see Chittibabu et al., page 14, paragraph [0100]; present published specification at page 1, paragraph [0013]). Although this co-sensitizer is co-adsorbed with the sensitizing dye on the semi-conductive metal oxide layer, both compounds do not share the same function or achieve the same result. The co-sensitizer of Chittibabu et al. is an electron donor and improves the efficiency of charge transfer from the sensitizing dye to the semiconductor oxide particles. The compacting compound of the present invention is not an electron donor (see Chittibabu, page 13, paragraph [0095]; present published specification at page 4, paragraph [0031]). Accordingly, the compacting compound of the present invention is not a co-sensitizer within the meaning of Chittibabu et al., namely a compound being an electron donor and part of the sensitizing agent (see Chittibabu et al., page 13, paragraph [0097]). The compacting compound of the present invention does not function as a co-sensitizer. It builds with dye molecules a self-assembled compact mixed monolayer on the semiconductive metal oxide layer and hinders the access of polar species present in the electrolyte to the surface of said layer (see present specification at page 2, paragraphs [0015]-[0022]; and a from page 7, Example 4 to page 8, Example 6, paragraph [0081]).

Chittibabu et al. concerns another problem that required a different invention in the field of dye-sensitized solar cells: how interconnecting nanoparticles at low temperatures with compounds that have the ability to donate electrons to the sensitising dye and improving charge transfer from the sensitising dye to the semiconductor oxide nanoparticle material (see Chittibabu et al., page 13, paragraph [0095]). Accordingly, how could one of ordinary skill in this art think that the teaching of Chittibabu et al. would help him find the solution to the objective problem solved by the present invention, namely increasing the thermostability of dye-sensitized solar cells (see present published specification at page 1, paragraph [0012], lines 4-6). Chittibabu et al. does not disclose the solution to the objective problem solved by the present invention, namely a regenerative photoelectrochemical cell comprising compacting compounds of formula (1) or (2), which are co-adsorbed with the sensitising dye. As a result, present amended Claim 1 is considered to be non-obvious over Chittibabu et al.

Accordingly, Claims 3, 12, 23 and 24, which depend from amended Claim 1, which claim specific embodiments of the photoelectrochemical cells of the present invention, are also considered to be ipso facto non-obvious over Chittibabu et al.

3.2. Claims 13 to 15

Claims 13 to 15 were rejected under 35 USC 103(a) as being unpatentable over Chittibabu et al. in view of Sigma-Aldrich.

Applicants respectfully request reconsideration and withdrawal of this rejection in the light of the arguments below.

Claims 13 to 15 claim specific embodiments of the photoelectrochemical cell of the present invention as claimed in amended Claim 1. Since no compacting compound selected from formula (1) or (2) are taught by Chittibabu et al. or by Sigma-Aldrich, claims 13 to 15

cannot be found to be obvious over Chittibabu et al., alone, or in combination with Sigma-Aldrich.

3.3. Claim 22

Claim 22 is rejected under 35 USC 103(a) as being unpatentable over Chittibabu et al. in view of Green et al.

Claim 22 claims a specific embodiment of amended Claim 1, the composition of the electrolyte of the photoelectrochemical cell of the present invention as claimed in amended Claim 1. Since Claim 22 is dependent of amended Claim 1, which is regarded as novel and non-obvious as amended, Claim 22 is also considered to be non-obvious over Chittibabu et al. in view of Green et al.

Moreover Green et al. discloses an electrolyte comprising molten salt for electrochemical cells, batteries and supercapacitors for improving their stability and conductivity. Since Green et al. do not teach photoelectrochemical cells and certainly do not teach photoelectrochemical cells as claimed in amended Claim 1, comprising compacting compounds of formula (1) or (2), and do not teach how to improve the thermostability and the efficiency of the photoelectrochemical cell as claimed in amended Claim 1, there is no incentive for a person of ordinary skill in this art to modify the teaching of Chittibabu et al. with the teaching of Green et al. to obtain the photoelectrochemical cells of the present invention. Therefore, Claim 22 is not rendered obvious by Chittibabu et al. alone or in view of Green et al.

Applicants respectfully request the reconsideration and withdrawal of this rejection in the light of the arguments above.

3.4. Claims 27 to 29

Claims 27 to 29 were rejected under 35 USC 103(a) as being unpatentable over

Chittibabu et al. in view of Misra et al. who teach how to avoid damages and destructions of molecules in the crossbar array structure of microelectronic electrochemical cells during the deposition and patterning of the second set of metal lines during the fabrication of said structure (see Chittibabu et al. at page 1, paragraph [0005], lines 7 to 10).

Claims 27 to 29 claim specific embodiments of the regenerative photoelectrochemical cells of the present invention as claimed in amended Claim 1, comprising compacting compounds of formula (1) or (2), and further comprising an effective gelifying amount of gelifying compound in the electrolyte.

Accordingly, there is no incentive for a person of ordinary skill in the art to apply a method of fabrication of a crossbar array structure as taught by Misra et al. to the method of interconnecting metal oxide nanoparticles for enabling the fabrication of thin film solar cells at relatively low temperatures as described by Chittibabu et al. to produce the photoelectrochemical cells of the present invention as claimed in amended Claim 1.

Therefore, it would not have been obvious at the time of the invention for an ordinarily skilled person to adapt the method of Chittibabu et al. with the teachings of Misra et al. to achieve the photoelectrochemical cells of the present invention.

Since amended Claims 28 and 29 depend from Claim 27, which depends from amended Claim 1, which is considered as being novel and non-obvious over the prior art of record for the reasons already expressed, Claims 27 to 29 are considered to be ipso facto non-obvious over Chittibabu et al. in view of Misra et al.

In view of the above arguments, Applicants request the reconsideration and withdrawal of this rejection.

4. Conclusion

For all these foregoing reasons, Applicants request entry of the foregoing amendments to the Claims, reconsideration of the present application in light thereof, and in light of the foregoing remarks, followed by a Notice of Allowance of all the pending Claims, as amended, over all the prior art of record.

Respectfully Submitted,

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